

Suggestions for Literature Review of Threatened or Impaired Watershed regulations

The Board of Forestry (BOF) has requested public input on reviewing technical scientific literature regarding the Threatened and Impaired Watersheds (14 CCR 916.9, 936.9, 956.9) rule. One goal of this rule is for Watercourse and Lake Protection Zones (WLPZ's) to provide for protection of the beneficial uses of water, riparian habitats, and stream channels for anadromous salmonids. Review of the scientific literature should focus on the interaction between the life-cycle needs of anadromous salmonids, riparian and aquatic habitats, stream characteristics, and impacts, both positive and negative, from nearby forest management activities. To better understand the current scientific understanding of these interactions, the Board of Forestry is encouraged to synthesize the scientific literature along the following guidelines.

Board of Forestry Item a. Establish specific purpose and questions...

There are six ecological features (or structures and functions) that have been identified as critical components of functional riparian habitats. The Board of Forestry should classify scientific literature by these ecological features (if literature meets certain standards) and use the literature to evaluate potential positive and negative effects from forest management activities under past and present rules. Some technical literature may address single features while others may address several. The BOF will be examining these features to determine if certain management activities have an effect and will then need to determine if regulations enacted effectively maintain, enhance, or restore critical ecological features.

To make the review process consistent between ecological features, each feature and subsequent Key Question and Additional Question are structured following a specific format. Key Questions ask whether the scientific understanding of ecological theory is supported by research and then at what distance(s) from the stream channel does the feature contribute to the stream channel. Additional Questions are questions, which may or may not have a direct bearing on forest management activities but may provide insight into understanding the larger ecological role of the ecological feature.

(1) **Nutrients** can be supplied to the stream channel through leaf litter fall.

Key Questions for Review: Does leaf litter fall from riparian habitats have any bearing on the nutrient levels with stream zones? At what distance(s) from the stream channel are nutrients supplied from leaf litter fall?

Additional Questions for Review (if available): Does thinning within the WLPZ cause changes in the forest composition between conifers and deciduous hardwoods which then result in changes in the yearly pattern of litter fall?

(2) **Bank Stability** Channel armoring by boulders and cobbles, imbedded large woody debris, and streamside tree roots can provide stream bank stability necessary for channel stabilization.

Key Questions for Review: What is the contribution of each of these to stream channel stability in different types of channels and watersheds? At what distances(s) from the stream channel does root strength from streamside trees provide stream bank stabilization?

Additional Questions for Review (if available): Does the type (conifer or hardwood) or species of trees influence this relationship? How does harvesting impact the root strength contribution to channel stability? How does removal or placement of large woody debris contribute to channel stability? How does removal (e.g., at a watercourse crossing) or placement of coarse rock contribute to channel stability?

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(3) **Vegetative Shade** may moderate stream temperatures by reducing direct solar radiation.

Key Questions for Review: What is the effect of shade-producing canopy on a specific stream's water temperature regime? If shade-producing canopy has an effect, at what distances from the stream channel is shade-producing canopy effective? What reductions in the shade-producing canopy are possible before significant effects occur? Additional Questions for Review (if available): Are the different vegetative shade measurement devices comparable and are any differences important in predicting potential changes in water temperature due to harvest?

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(4) **Coarse Woody Debris** is recruited from vegetation and contributes to complex fish habitats.

Key Questions for Review: What are the primary ecological process(s) that result in the recruitment of coarse woody debris into stream channels? From each of these ecological process(s), at what distances is coarse woody debris recruited?

Additional Questions for Review (if available): Can forest management activities impact natural wood recruitment processes? Can the quality of large woody debris be artificially enhanced by forest management activities?

(5) **Microclimates** created by streamside vegetation, in addition to solar radiation, influence ambient air temperature, relative humidity, and wind speed which effect stream water temperature regimes.

Key Questions for Review: What is the relationship between measurable riparian microclimate air temperatures, relative humidity and wind speed and stream water temperatures? Do changes in microclimate air temperatures, relative humidity and wind speed impact, positively or negatively, the overall stream water temperature budget? At what distance from the stream channel does microclimate impact, positively or negatively, stream water temperatures? [How does canopy structure influence microclimate: Does a multi-storied canopy have a different moderating effect than a single-storied canopy?](#)

(6) **Sediment** from overland flow can be filtered by riparian and upland habitat vegetation.

Key Questions for Review: What are the primary types of overland flow sedimentation? What kinds of potential disturbances can be associated with these primary types? At what distance to the stream channel do riparian habitats ameliorate sediment flow to the stream channel? How does the overall percentage of stream sedimentation from overland flow vary with watershed characteristics? [How do roads \(especially watercourse crossings\) and landings affect sediment delivery \(including mass wasting\) to watercourses? What differences can be made by location, design, construction, use and maintenance of such facilities? How effective are riparian buffers in intercepting flow through gullies, debris flows, and landslides?](#)

Additional Questions for Review (if available): What types of forest management activities impact different types of overland flow [and mass wasting](#) sediment sources? What regulations exist to ameliorate sediment production in streamside zones and are they effective?

(7) **Natural Variability** from watershed to watershed is typically due to a watershed's unique physical condition (i.e. space) and unique history of natural disturbances (i.e. time). The physical condition of a watershed can vary due to, but not limited to; geology, climate, precipitation patterns and resulting vegetation types. The natural disturbance history is our attempt to measure time, but in fact the watershed or stream channel is in constant change over time and review of scientific information should be aware of this variability.

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(8) **Stochastic Events** In addition to understanding the ecological features and natural variability, it is also important to assess other more stochastic natural events. Riparian habitats are typically changed by natural disturbances such as fire, flooding, and windthrow. Stream channels can be changed by disturbances such as landslides, lateral channel erosion, peak flow flooding, and deposition of debris during peak flows. All of these disturbances help create a highly diverse riparian plant communities and complex stream channel habitats (Gregory *et al.* 1991). Accordingly, uncertainty caused by stochastic events requires that riparian habitats and stream channel protection measures be reviewed and assessed on a site-by-site basis as described in the Forest Practice Rules.

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(9) **Channel Stability** Channels can migrate either vertically (aggradation or degradation) or horizontally (accretion or avulsion) and management activities can affect such changes. How can bank and floodplain vegetation affect these changes? How can disturbances of bank or floodplain soils (especially by watercourse crossings) affect these changes?

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(10) **Flow** Changes in the volume and duration of peak flood flows, low flows and total flow can affect channel and bank stability, sediment delivery, water quality, and aquatic habit. What degree or threshold of change is significant to anadromous salmonids? How can management activities (especially the surfaces of roads and landings and water drafting) affect the flow regime within a watercourse or watershed?

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(11) **Water Quality and Aquatic Habitat** Changes in water quality can affect anadromous salmonids either directly (e.g., turbidity reducing feeding effectiveness, temperature) or indirectly through effects on aquatic habitat (e.g., filling of pools needed for rearing, embedding of spawning gravels, impact on food organisms).

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(12) **Life-Cycle Needs of Anadromous Salmonids** What is understood about the life-cycle needs (e.g., quality of spawning and rearing habitat, migration routes) of anadromous salmonids should be the basis of the entire effort. What kinds of habitat quality and access is optimal for life-cycle needs? What quality, although sub-optimal, is necessary and sufficient to sustain a viable species populations? Are there any thresholds below which populations will not thrive or even survive?

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Board of Forestry Item c. Establish criteria by which literature will be reviewed. Criteria may include factors addressed by the literature, date of literature, the type, scale, and level of detail of the study, and the applicability of the results to the Forest Practice Rules.

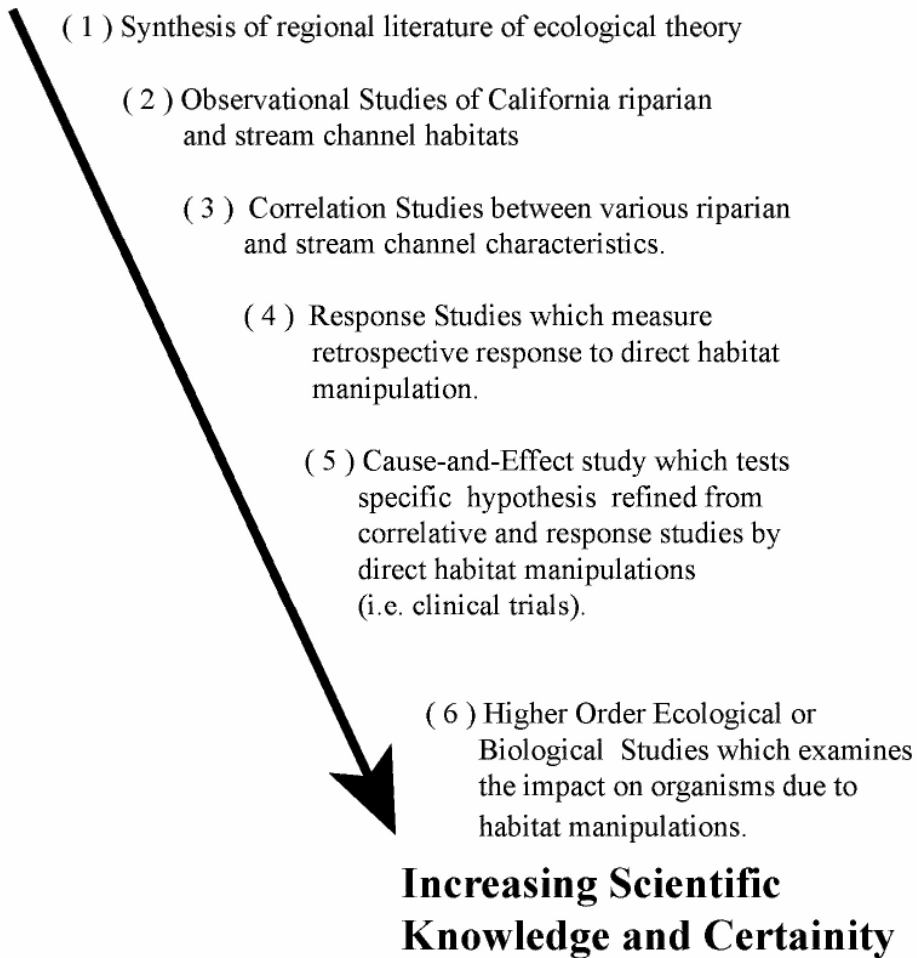
To understand **the applicability of scientific information**, it is necessary to examine the type of study the scientific information is based upon. Scientific understanding of complex natural systems occurs within a hierarchical framework. The hierarchy begins with postulated theory about ecological processes and proceeds down to a series of tests of the hypothesis. The Board of Forestry should review each piece of scientific literature with this hierarchy in mind. A thoughtful assessment of the interactions between riparian and stream channel habitats and current forest management activities should consider the following hierarchy, recognizing that, as the scale of a study is decreased, scientific knowledge and certainty increase at the site-specific scale, but decrease in its application on a larger (regional) scale:

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Hierarchy of Scientific Studies



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Board of Forestry Item d. Determine format for presenting summary of literature.

The goal of the review should be to conduct an assessment of the scientific literature in a thoughtful and repeatable manner. Objective assessment requires evaluating the scientific information presented by specific design standards. It is important that the limits and assumptions used in the study are acknowledged and documented. The use of summary tables or crosswalks should be discouraged as they typically miss key points and consequently overstate the studies applicability or disguise the study's uncertainties and limitations. At a minimum, the review should address both the Key Questions and Additional Questions described above. The review should summarize the literature following the ten points detailed below and adhere to this process for each piece of literature:

- (1) **Short paragraph:** A paragraph that summarizes or quotes the key findings of the study. In addition to the key findings the paragraph(s) should briefly summarize all of the following items 2 through 10.
- (2) **Type of study:** At a minimum, use the Hierarchy of Scientific Studies described above to categorize each study. Is it a literature review, observations study, or cause-and-effect study?
- (3) **Type of Process:** At a minimum, describe the type of process (es) that is the primary basis of the study. Is it physical, biological, or both? Examples might be a geological, vegetative, climate or biological process(s).
- (4) **Time frame of Study:** At a minimum, state the time period of the study and the number of year(s) or season(s) the study was conducted. Also, did the study evaluate current or past forest management activities? Also, describe if the study was conducted using modern technological measurement techniques and what field measurement techniques were used? How does the timing of the study relate to stochastic events?
- (5) **Validity or Accuracy:** At a minimum, review the validity and accuracy of the study. Validity would be how well are the results supported by the methods and study design. Validity would also be how well are the author's conclusions supported by the results? Accuracy would include the precision (e.g. standard errors) of quantitative estimates.
- (6) **Uncertainty or Limitations and Assumptions:** At a minimum, review the levels of uncertainty or possible limitations of the study, and what assumptions, if any, were made in developing the study? Uncertainty (if any) should be described in terms of how representative the study is, does it have appropriate sample sizes, and are results conclusive. Limitations of a study (if any) should be described in terms of type of study, type of process, time frame, validity and accuracy.
- (7) **Applicability to California and Linkages to Regulations:** At a minimum, the review should state where the study was conducted (Country, State, County). The review should also include in which ecological province the study was conducted. Also, the review should describe what type of ecosystem (forested, unforested, mixed) the study was conducted in and what management regime (if any) was present (unmanaged, managed forest, sub-urban, urban). In general, what is the applicability of the study to California ecosystems and managed forests? What areas and types of streams are the focuses of this study? Is the literature result meaningful to current rule standards?

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- (8) **Biological or Public Resource:** At a minimum, the review should state the biological or public resource studied (if any). The review should describe the biological or public resources following:
- Type of resource (example: fish, amphibian, macroinvertebrate, domestic water supply),
 - Direct or indirect measurement of the resource,
 - Short-term or Long-term measurement of resource in relation to life stage or life expectancy.
 - Measurement of resource life stage(s)
 - List potential direct or indirect impacts, both positive and negative, to the resource identified in the study in addition to forest management activities.
- (9) **Statistical Significance and Biological Relevance:** If statistical significance was found, how does it relate to biological relevance? In other words, does the established statistical relationship have potential linkage with substantial biological effects in the stream channel?
- (10) **Attribute List Creation:** In order to place the literature review in a relational database an attribute list needs to be constructed. For example: Area of Applicability (1=north Coast, 2=Modoc Plateau), Stream Size Class (0-5 CFS, 6-10 CFS, >30 CFS), Fish Present (Anadromous=1, Native Non-Anadromous=2), etc.

Form MSG Sub-Group to Aid in Implementation of Literature Review

We recommend a sub-group of the MSG be identified as coordinators of this project. They would help coordinate list compilation, determine who will best perform literature reviews, pass literature to people best qualified to review, adhere to process and structure established by the Board of Forestry, summarize rules and resource protection measures potentially affected by literature assessment, meet timelines, deadlines and recommendations for rule modification.

As stated previously, the review of scientific literature should focus on the interaction between riparian habitat, stream characteristics and impacts, both positive and negative, from nearby forest management activities. To better understand this interaction the sub-Group of the MSG would synthesize the scientific literature using the following structure:

- (1) Life cycle needs of anadromous salmonids.
- (2) Ecological structures and functions of functional riparian and aquatic habitats.
- (2) Use the Hierarchy of Scientific Studies to guide review of scientific literature
- (3) Use the ten point format described above for consistency and repeatability.

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The results of the literature review would be summarized by the sub-Group of the MSG. Based on this groups cumulative knowledge and experience with California Forest Practice Rules and their Implementation, the sub-Group of the MSG would identify scientific linkage(s) between the scientific literature reviewed and California Forest Practice Rules. The sub-Group of the MSG would also identify resource protection measure(s) potentially affected by literature assessment.

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